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SOLAR/2009-79/05

Monthly Performance Report

RADEMAKER CORPORATION

MAY 1979

FEB 26 1980

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

4265

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MONTHLY PERFORMANCE REPORT
RADEMAKER CORPORATION
MAY 1979

I. SYSTEM DESCRIPTION

The solar energy heating system at Rademaker Corporation is designed to provide 50 percent of the space heating and 50 percent of the domestic hot water preheating for a 10,000-square foot office and warehouse building in Louisville, Kentucky. The solar installation, by design, consists of two separate solar energy systems. One system utilizes liquid as the energy transfer medium; the other system utilizes air as the transfer medium. The purpose of separate solar energy systems was to evaluate the merits of each system in meeting a common space heating load. The two solar heating systems are shown schematically in Figure 1.

The liquid system has an array of six flat-plate collectors with a gross area of 240 square feet. The array faces south at an angle of 53 degrees from the horizontal. A solution of 46 percent propylene glycol and 54 percent water is employed as a heat transfer medium. Solar energy is stored in a 560-gallon thermal storage tank located in the warehouse. Solar energy is transferred to meet the space heating demand by two methods. In the first method, solar heated hot water is circulated on demand, from water thermal storage to heat exchangers HX2 and HX3 in the supply ducts of the drafting room and perimeter zone, respectively. In the second method, the glycol and water solution in the collection loop is directed, on demand, to heat exchanger HX4 in the supply duct of the perimeter zone. Circulation fans F2 and F3 distribute the solar energy to meet the space heating loads. Energy is also distributed to a domestic hot water heat exchanger that extracts solar energy from the glycol and water solution to preheat domestic hot water in the building.

The air system has an array of 10 flat-plate collectors with a gross area of 195 square feet. The array faces south at an angle of 33 degrees

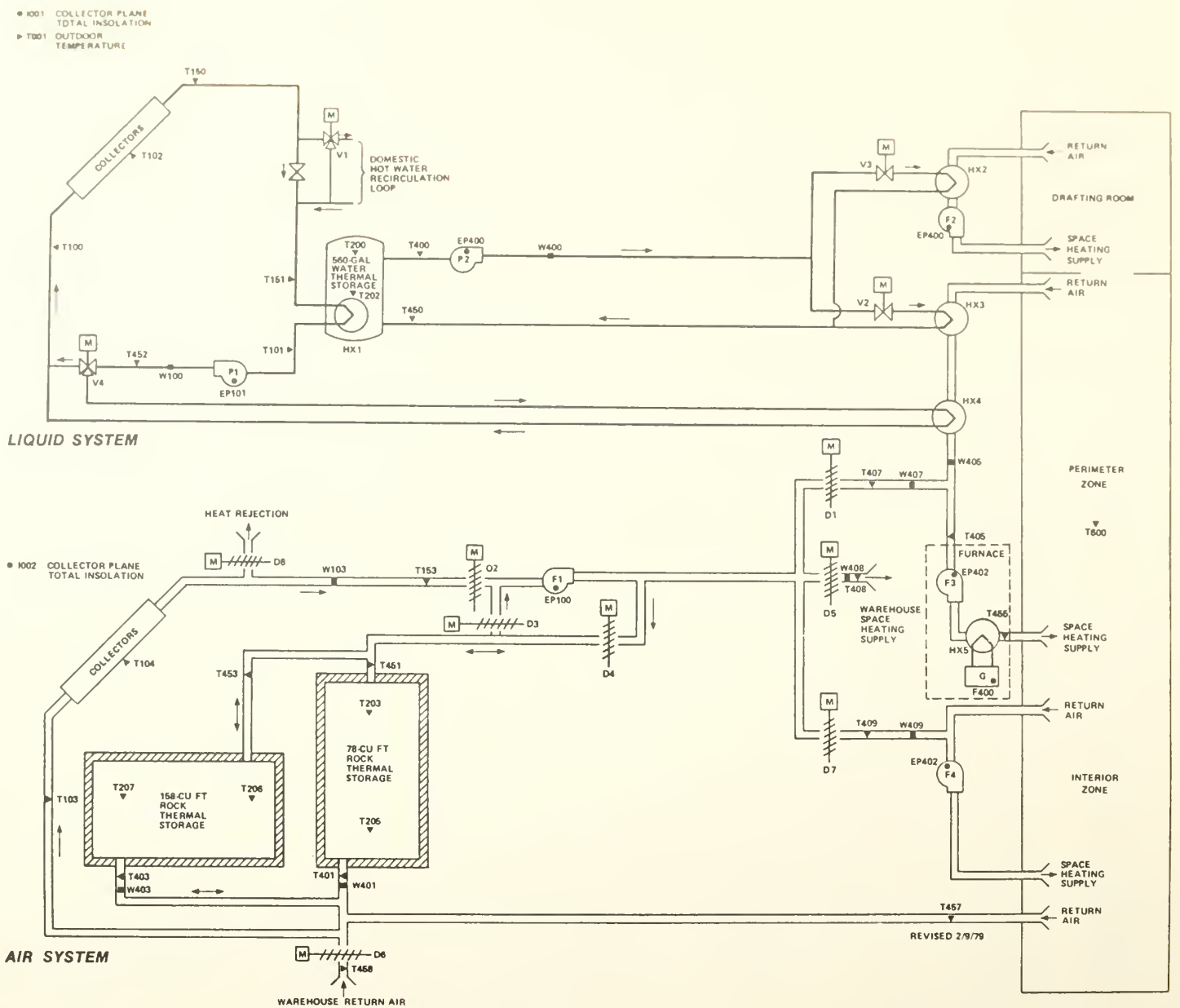

Figure 1. RADEMAKER CORPORATION SOLAR ENERGY SYSTEM SCHEMATIC

from the horizontal. Solar energy is stored in two rock thermal storage units in the warehouse which contain a total of 236 cubic feet of crushed rock. Solar energy is transferred to meet the perimeter, warehouse, and interior zone space heating demands using circulation fan F1. Circulation fans F3 and F4 distribute energy to the perimeter and interior zones, respectively. Solar heated air can be distributed directly from the collectors, or from rock thermal storage to meet the space heating loads. The solar energy control system determines which space heating load received solar energy when a demand exists. The solar space heating load priorities are: first, interior zone heating; second, perimeter zone heating; and third, warehouse heating.

Solar heated air from the liquid system is mixed in the air-handling unit plenum with solar heated air from the air system and distributed to the perimeter zone using circulation fan F3. When solar energy is inadequate to provide perimeter zone space heating, auxiliary thermal energy is supplied by a natural-gas furnace.

The liquid system has four modes of operation.

Mode 1 - Collector-to-Storage: This mode is entered when the difference between the collector outlet temperature and the water thermal storage temperature is greater than 14°F. Pump P1 circulates the liquid through the collectors, then to storage heat exchanger HX1 and returns to the collectors. Circulation continues in this mode until the temperature difference between the collector outlet and storage is less than 4°F.

Mode 2 - Storage-to-Conditioned Space: This mode is entered when two conditions are satisfied: first, a demand for space heating exists; secondly, the temperature of the storage water is above 85°F. Water is circulated from storage to heat exchangers HX2 and HX3 located in the supply ducts of the drafting room and perimeter zone. Air circulation fans F2 and F3 distribute the solar energy to the space heating zones. This mode continues until the storage temperature is below 85°F or the demand for space heating is satisfied.

Mode 3 - Collector-to-Conditioned Space: This mode is entered when two conditions are satisfied: first, the temperature of the liquid at the outlet side of heat exchanger HX1 is greater than 120°F; secondly, there is a demand for space heating from the perimeter zone. Solar energy is directed by valve V4 to heat exchanger HX4 in the supply duct of the perimeter zone. Fan F3 distributes the solar energy to the perimeter zone. This mode continues until either the temperature at the outlet of heat exchanger HX1 is less than 120°F, or the demand for space heating is satisfied. Auxiliary space heating supplements solar energy for the perimeter zone.

Mode 4 - Domestic Hot Water Preheating: This mode is entered when solar hot water heating is desired and solar energy is available from the collectors. Solar energy is directed from the collector loop through the domestic hot water (DHW) recirculation loop to preheat hot water for DHW consumption. A high limit thermostat shuts off the flow to the DHW heat exchanger in the recirculation loop when the liquid temperature exceeds 180°F.

The air system has four modes of operation.

Mode 5 - Auxiliary Space Heating: This mode is entered when the collectors are inactive, the storage temperatures of both solar systems are below 85°F, and a demand for space heating exists. Circulation fan F3 supplies auxiliary energy from the furnace to the perimeter zone. Circulation continues in this mode until the demand for space heating is satisfied or solar energy is available from either the collectors or storage.

Mode 6 - Collector-to-Storage: This mode is entered when two conditions are satisfied: first, the difference between the collector outlet temperature and the bottom of storage is greater than 14°F; secondly, there is no demand for space heating. Fan F1 circulates air from storage, through the collectors, and then back to storage. Circulation continues in this mode until the differential temperature is less than 4°F, or until a demand for space heating occurs. In this mode, motorized dampers

D1, D3, D5, D6, D7 and D8 are closed, and motorized dampers D2 and D4 are opened.

Mode 7 - Storage-to-Conditioned Space: This mode is entered when a demand for heating exists, the collector loop is inactive, and the top of rock thermal storage is above 85°F. Fan F1 circulates building return air through storage and supplies solar heated air to the space heating zone demanding heat. The solar control system determines which space heating zone is supplied with heat. Circulation continues in this mode until the storage temperature drops below 85°F, or the demand for space heating ceases. In this mode, motorized dampers D1, D5, D6 and D7 are opened, or closed, depending upon which area requires heat. For proper air circulation through storage, dampers D2 and D4 are closed, and D3 is opened.

Mode 8 - Collector-to-Conditioned Space: This mode is entered when two conditions are satisfied: first, a demand for space heating exists from the perimeter zone, interior zone, or warehouse; secondly, the differential temperature between the collector outlet and the bottom of rock thermal storage is greater than 14°F. Fan F1 circulates air from conditioned space through the collectors and supplies solar heated air to area demanding heat. The solar control system has a priority scheme that determines the order in which zone is supplied heat. Fans F3 and F4 assist in the air distribution. This mode continues until either the differential temperature between the collector outlet and the bottom of storage is less than 4°F, or the demand for space heating ceases. The auxiliary furnace supplements solar energy for the perimeter zone only. In this mode, motorized dampers D1, D5, D6 and D7 are either opened, or closed, as determined by heating requirements. To circulate air only through the collectors, motorized dampers D3, D4 and D8 are closed, and damper D2 is opened.

The liquid system and the air system operate independently; however, either system may be used in conjunction with the auxiliary furance to satisfy a heating demand.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data. The performance factors discussed in this report are based upon the definitions contained in NBSIR 76-1137, Thermal Data Requirements and Performance Evaluations Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

In the month of May, the predominate load was DHW which was, therefore, the major contributor to the fossil savings. Auxiliary fossil requirements for heating were minimal resulting in a solar fraction of 95 percent for the combined systems. This is a transitional month for heating and the air system was used on only 50 percent of the days of the month.

During May, 95 percent of the 1.73 million Btu space heating system load was provided by solar energy, resulting in a fossil energy savings of 4.15 million Btu at an electrical energy cost of 0.77 million Btu.

For the air system, 99 percent of the 0.82 million Btu system load was provided by solar energy, resulting in a fossil energy savings of 1.34 million Btu at an electrical energy cost of 0.24 million Btu. The energy collection and storage subsystem and the space heating subsystem were operational during the entire month.

For the liquid system, 91 percent of the 0.91 million Btu space heating system load was provided by solar energy, resulting in a fossil energy savings of 1.37 million Btu at an electrical energy cost of 0.52 million Btu. The energy collection and storage subsystem, the space heating subsystem, and the DHW preheating subsystem were operational during the entire month.

B. Weather

During May, the temperature in Louisville, Kentucky was cooler by 1°F, as evidenced by an average outside ambient temperature of 64°F when compared to the long-term value of 65°F. This long-term value was obtained from the climatological data for the city of Louisville, Kentucky.

The average insolation of 1,404 Btu/ft^2-day was greater than the long-term value of 1,370 Btu/ft^2-day obtained from an algorithm that projects the mean daily horizontal insolation into the plane of the collectors.

C. Thermal Performance (Liquid System)

Collector - During May, 10.45 million Btu of solar energy were incident upon the collector array, and 8.15 million Btu were incident during the operation of the subsystem. From this amount, 2.97 million Btu were collected, resulting in a collector array efficiency of 28 percent. A total of 0.14 million Btu of electrical energy was required to operate the subsystem.

Storage - From the 2.97 million Btu of solar energy that were collected, 0.86 million Btu were delivered to the DHW preheating subsystem, 1.69 million Btu were delivered to thermal storage, and the remaining 0.42 million Btu were lost during transport. From storage, 0.68 million Btu were removed from the space heating subsystem and 0.93 million Btu were lost to the warehouse, resulting in a storage efficiency of 45 percent. The average storage temperature was 117°F.

Space Heating - A total of 0.82 million Btu of solar energy was delivered to the subsystem. Of the total auxiliary energy used (0.10 million Btu), 0.09 million Btu of thermal energy were apportioned to the liquid system. A total of 0.60 million Btu of electrical energy was required to operate the subsystem, including the apportioned furnace air handler blower power. Solar energy supplied 91 percent of the 0.91 million Btu subsystem load, resulting in a fossil energy savings of 1.37 million Btu, at an electrical energy cost of 0.52 million Btu.

Domestic Hot Water - The DHW subsystem is instrumented to identify the energy extracted from the collected energy and delivered to the DHW recirculation loop. The operating energy and the energy used by the DHW load cannot be identified. The solar energy delivered to the subsystem was 0.86 million Btu.

D. Thermal Performance (Air System)

Collector - During May, 9.20 million Btu of solar energy were incident upon the collector array, and 3.90 million Btu were incident during the operation of the subsystem. From the incident energy, a net amount of 1.27 million Btu were collected.

The collector array efficiency was only 14 percent which resulted from no operation of the array for 14 days of the month. A total of 0.15 million Btu of electrical energy was required to operate the subsystem.

Storage - From the net amount of 1.27 million Btu of solar energy that was collected, 0.35 million Btu were delivered to storage, and the remainder was delivered directly to the space heating load or lost in transport.

The net energy from storage was 0.12 million Btu and the storage efficiency was 26 percent. The average daily storage tank temperature was 75°F which is below the 85°F set point for storage-to-conditioned space operation (Mode 7).

Space Heating Subsystem - A total of 0.81 million Btu of solar energy was delivered to the subsystem. Of the total auxiliary energy used (0.10 million Btu), 0.12 million Btu of thermal energy were apportioned to the air system. A total of 0.31 million Btu of electrical energy was required to operate the subsystem, including the apportioned furnace air handler blower power. Solar energy supplied 99 percent of the 0.82 million Btu subsystem load, resulting in a fossil energy savings of 1.34 million Btu, at an electrical energy cost of 0.24 million Btu.

E. Thermal Performance (Combined Systems)

The thermal performance of the combined liquid and air systems includes the solar energy extracted from the liquid collector loop for use by the DHW subsystem in the calculation for fossil savings and solar fraction. It has not been included in the total load or solar energy used because the auxiliary DHW energy is unknown. Accordingly, the solar fraction of the overall system is high because the missing auxiliary energy factor which, as a nominal part of the total load, is in the denominator of the solar fraction expression. The Rademaker DHW load is estimated to be 10 percent or less of the heating load and, therefore, this effect is not great.

A total of 1.63 million Btu of solar energy was delivered to the space heating subsystems and 0.86 million Btu were delivered to the DHW pre-heating subsystem. From the 0.87 million Btu of fossil energy available to the furnace, 0.1 million Btu of thermal energy were delivered to heat exchanger HX5. A total of 0.92 million Btu of electrical energy was required to operate the systems. The solar fraction was 95 percent. The solar energy used resulted in fossil energy savings of 4.15 million Btu, at an electrical energy cost of 0.77 million Btu.

F. Observations

The liquid system performed well in providing solar energy for the DHW subsystem. The liquid and air systems provided nearly equal amounts of solar energy but since the air system was allowed to operate for so few days in the month, it may have been a better option to simply turn off the air system for the season.

G. Energy Savings

During May, the combined system fossil energy savings, including the solar contribution to the DHW subsystem, were 4.15 million Btu. These savings are based on a furnace efficiency of 0.60 in the conversion of fossil energy to

usable thermal energy. The electrical energy savings were -0.77 million Btu which is the equivalent operating energy that would have been required to satisfy the observed monthly load by the gas furnace less the operating energy that was used.

The following percentage of time in the month of May that the air system operated in the solar mode and the total system operated in the non-solar modes is listed:

No Solar Operation	41.4 Percent
Solar Operation	18.8 Percent
Auxiliary Heating Only	0 Percent
Ventilating Only	39.8 Percent

During solar operation, the air system had the following breakdown of time duration:

Collector-to-Load	3.1 Percent
Storage-to-Load	1.7 Percent
Collector-to-Storage	19.0 Percent

III. ACTION STATUS

The site contractor has an open action item to correct the damper leaks and the control of damper D1 which now opens when there is a demand for heating regardless of whether solar energy is available. It has also been recommended to the site contractor that the 158-cubic foot rock thermal storage be completely disabled.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: RADEMAKER CORP.-AIR SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

SITE/SYSTEM DESCRIPTION:
THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ.FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING AIR THROUGH 10 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO EITHER THE OFFICE AREA OR TO A 236 CU.FT. THERMAL STORAGE UNIT. THE SYSTEM IS AUGMENTED BY HEAT FROM A 125,000 BTU/HR, NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	9.201	MILLION BTU
	47186	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	1.265	MILLION BTU
	6489	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	64	DEGREES F
AVERAGE BUILDING TEMPERATURE	73	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.09	
ECSS OPERATING ENERGY	0.146	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.161	MILLION BTU
TOTAL ENERGY CONSUMED	1.823	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	0.818	N.A.	0.818 MILLION BTU
SOLAR FRACTION	N.A.	99	N.A.	99 PERCENT
SOLAR ENERGY USED	N.A.	0.806	N.A.	0.806 MILLION BTU
OPERATING ENERGY	N.A.	0.015	N.A.	0.161 MILLION BTU
AUX. THERMAL ENERGY	N.A.	0.012	N.A.	0.012 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	N.A.	0.397	N.A.	0.397 MILLION BTU
ELECTRICAL SAVINGS	N.A.	0.000	N.A.	-0.146 MILLION BTU
FOSSIL SAVINGS	N.A.	1.343	N.A.	1.343 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.877

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: RADEMAKER CORP.-AIR SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

SITE/SYSTEM DESCRIPTION:
THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ.FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING AIR THROUGH 10 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO EITHER THE OFFICE AREA OR TO A 236 CU.FT. THERMAL STORAGE UNIT. THE SYSTEM IS AUGMENTED BY HEAT FROM A 125,000 BTU/HR. NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	9.707 GIGA JOULES
	535846 KJ/SQ.M.
COLLECTED SOLAR ENERGY	1.335 GIGA JOULES
	73684 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	18 DEGREES C
AVERAGE BUILDING TEMPERATURE	23 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.09
ECSS OPERATING ENERGY	0.154 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.170 GIGA JOULES
TOTAL ENERGY CONSUMED	1.924 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	0.863	N.A.	0.863 GIGA JOULES
SOLAR FRACTION	N.A.	99	N.A.	99 PERCENT
SOLAR ENERGY USED	N.A.	0.850	N.A.	0.850 GIGA JOULES
OPERATING ENERGY	N.A.	0.016	N.A.	0.170 GIGA JOULES
AUX. THERMAL ENG	N.A.	0.012	N.A.	0.012 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	N.A.	0.419	N.A.	0.419 GIGA JOULES
ELECTRICAL SAVINGS	N.A.	0.000	N.A.	-0.154 GIGA JOULES
FOSSIL SAVINGS	N.A.	1.417	N.A.	1.417 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.877

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978. SOLAR/0004-78/18

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.432	59	0.096	N	0.012	N	0.221
2	0.258	64	0.044	O	0.008	O	0.172
3	0.106	63	0.015	T	0.007	T	0.143
4	0.035	50	0.004		0.001		0.101
5	0.465	53	0.128	A	0.014	A	0.275
6	0.458	60	0.111	P	0.013	P	0.242
7	0.453	70	0.070	P	0.012	P	0.155
8	0.433	75	0.000	L	0.001	L	0.001
9	0.191	73	0.000	I	0.000	I	0.000
10	0.366	78	0.000	C	0.000	C	0.000
11	0.314	77	0.000	A	0.000	A	0.000
12	0.053	58	0.000	B	0.001	B	0.008
13	0.436	59	0.016	L	0.006	L	0.036
14	0.442	64	0.066	E	0.012	E	0.148
15	0.449	65	0.047		0.009		0.104
16	0.459	62	0.000		0.000		0.000
17	0.466	62	0.000		0.000		0.000
18	0.443	68	0.000		0.000		0.000
19	0.271	69	0.000		0.000		0.000
20	0.147	66	0.000		0.000		0.000
21	0.294	64	0.000		0.000		0.000
22	0.189	61	0.000		0.000		0.000
23	0.088	64	0.000		0.000		0.000
24	0.052	53	0.001		0.002		0.015
25	0.108	47	0.008		0.010		0.078
26	0.319	54	0.078		0.012		0.246
27	0.197	64	0.048		0.014		0.244
28	0.408	66	0.074		0.013		0.182
29	0.439	69	0.000		0.000		0.000
30	0.312	70	0.000		0.000		0.000
31	0.120	69	0.000		0.000		0.000
SUM	9.201	-	0.806	N.A.	0.146	N.A.	-
AVG	0.297	64	0.026	N.A.	0.005	N.A.	0.088
NBS ID	G001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: RACEMAKER CORP.-AIR SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.432	0.408	0.136	70	0.314
2	0.258	0.235	0.071	76	0.276
3	0.106	0.090	0.018	67	0.173
4	0.035	0.011	0.001	51	0.018
5	0.465	0.456	0.150	64	0.324
6	0.458	0.443	0.161	76	0.352
7	0.453	0.424	0.138	80	0.306
8	0.433	0.003	0.000	86	0.000
9	0.191	0.000	0.000	80	0.000
10	0.366	0.000	0.000	91	0.000
11	0.314	0.000	0.000	89	0.000
12	0.053	0.004	0.001	56	0.020
13	0.436	0.092	0.034	69	0.078
14	0.442	0.411	0.138	78	0.311
15	0.449	0.340	0.096	76	0.215
16	0.459	0.000	0.000	73	0.000
17	0.466	0.000	0.000	76	0.000
18	0.443	0.000	0.000	86	0.000
19	0.271	0.000	0.000	81	0.000
20	0.147	0.000	0.000	75	0.000
21	0.294	0.000	0.000	74	0.000
22	0.189	0.000	0.000	72	0.000
23	0.088	0.000	0.000	69	0.000
24	0.052	0.013	0.001	54	0.016
25	0.108	0.092	0.011	49	0.101
26	0.319	0.286	0.101	69	0.317
27	0.197	0.195	0.065	70	0.333
28	0.408	0.396	0.142	78	0.347
29	0.439	0.000	0.000	84	0.000
30	0.312	0.000	0.000	83	0.000
31	0.120	0.000	0.000	74	0.000
SUM	9.201	3.898	1.265	-	-
AVG	0.297	0.126	0.041	73	0.138
RESID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: RADEMAKER CORP.-AIR SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.055	0.028	0.015	80	0.799
2	0.020	0.007	-0.002	84	0.257
3	0.000	0.000	-0.013	82	-35.900
4	-0.001	0.002	-0.026	77	34.936
5	0.044	0.029	-0.003	73	0.586
6	0.039	0.005	0.030	73	0.905
7	0.041	0.009	0.030	81	0.945
8	-0.000	0.000	-0.024	85	143.333
9	0.000	0.000	-0.018	79	1.000
10	0.000	0.000	-0.008	75	1.000
11	0.000	0.000	-0.002	73	1.000
12	0.000	0.000	-0.003	73	-21.261
13	0.011	0.001	0.013	74	1.271
14	0.056	0.006	0.046	82	0.928
15	0.020	0.004	0.002	90	0.294
16	0.000	0.000	-0.045	81	1.000
17	0.000	0.000	-0.017	73	1.000
18	0.000	0.000	-0.005	70	1.000
19	0.000	0.000	-0.001	70	1.000
20	0.000	0.000	-0.000	70	1.000
21	0.000	0.000	-0.000	70	1.000
22	0.000	0.000	-0.002	69	1.000
23	0.000	0.000	-0.000	69	1.000
24	-0.000	-0.000	-0.001	69	18.558
25	-0.001	-0.001	-0.006	68	4.675
26	0.026	0.017	-0.001	69	0.616
27	0.022	0.003	0.019	70	0.981
28	0.019	0.007	0.047	78	2.899
29	0.000	0.000	-0.028	82	1.000
30	0.000	0.000	-0.017	76	1.000
31	0.000	0.000	-0.004	73	1.000
SUM	0.351	0.117	-0.025	-	-
AVG	0.011	0.004	-0.001	75	0.261
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MAY.1979

SOLAR/2009-79/05

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	N	N	N	N	N	N	N	N	N	N	N	N
2	O	O	O	O	O	O	O	O	O	O	O	O
3	T	T	T	T	T	T	T	T	T	T	T	T
4												
5	A	A	A	A	A	A	A	A	A	A	A	A
6	P	P	P	P	P	P	P	P	P	P	P	P
7	P	P	P	P	P	P	P	P	P	P	P	P
8	L	L	L	L	L	L	L	L	L	L	L	L
9	I	I	I	I	I	I	I	I	I	I	I	I
10	C	C	C	C	C	C	C	C	C	C	C	C
11	A	A	A	A	A	A	A	A	A	A	A	A
12	B	B	B	E	B	E	B	B	B	B	B	B
13	L	L	L	L	L	L	L	L	L	L	L	L
14	E	E	E	E	E	E	E	E	E	E	E	E
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												
SUM	N.A.	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	-	-	N.A.
AVG	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	CPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.096	100	0.096	0.003	0.000	N	0.013	0.000	0.159	73	59
2	0.044	100	0.044	0.001	0.000	O	0.013	0.000	0.074	73	64
3	0.015	100	0.015	0.000	0.000	T	0.014	0.000	0.025	74	63
4	0.004	102	0.004	0.000	0.000		0.016	0.000	0.006	72	50
5	0.132	97	0.128	0.002	0.004	A	0.014	0.000	0.213	70	53
6	0.111	100	0.111	0.002	0.000	P	0.017	0.000	0.185	71	60
7	0.070	100	0.070	0.002	0.000	P	0.012	0.000	0.117	76	70
8	0.000	100	0.000	0.000	0.000	L	0.006	0.000	0.000	77	75
9	0.000	0	0.000	0.000	0.000	I	0.004	0.000	0.000	74	73
10	0.000	0	0.000	0.000	0.000	C	0.007	0.000	0.000	75	78
11	0.000	0	0.000	0.000	0.000	A	0.014	0.000	0.000	75	77
12	0.000	100	0.000	0.000	0.000	B	0.013	0.000	0.001	74	58
13	0.016	100	0.016	0.000	0.000	L	0.011	0.000	0.026	69	59
14	0.066	100	0.066	0.001	0.000	E	0.009	0.000	0.109	74	64
15	0.047	100	0.047	0.001	0.000		0.010	0.000	0.078	75	65
16	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	74	62
17	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	73	62
18	0.000	0	0.000	0.000	0.000		0.015	0.000	0.000	74	68
19	0.000	0	0.000	0.000	0.000		0.013	0.000	0.000	74	69
20	0.000	0	0.000	0.000	0.000		0.013	0.000	0.000	73	66
21	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	73	64
22	0.000	0	0.000	0.000	0.000		0.016	0.000	0.000	72	61
23	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	73	64
24	0.001	100	0.001	0.000	0.000		0.014	0.000	0.001	72	53
25	0.008	100	0.008	0.000	0.000		0.019	0.000	0.014	69	47
26	0.085	92	0.078	0.002	0.007		0.017	0.000	0.131	69	54
27	0.048	100	0.048	0.000	0.000		0.014	0.000	0.080	71	64
28	0.075	100	0.074	0.000	0.000		0.011	0.000	0.124	71	66
29	0.000	0	0.000	0.000	0.000		0.012	0.000	0.000	73	69
30	0.000	0	0.000	0.000	0.000		0.013	0.000	0.000	74	70
31	0.000	0	0.000	0.000	0.000		0.013	0.000	0.000	75	69
SUM	0.818	-	0.806	0.015	0.012	N.A.	0.397	0.000	1.343	-	-
AVG	0.026	99	0.026	0.000	0.000	N.A.	0.013	0.000	0.043	73	64
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	2218	N	59	70	N	N	N
2	1324	C	64	76	C	C	O
3	541	T	63	67	T	T	T
4	177		50	51			
5	2385	A	53	64	A	A	A
6	2351	P	60	76	P	P	P
7	2322	P	70	80	P	P	P
8	2223	L	75	86	L	L	L
9	977	I	73	80	I	I	I
10	1879	C	78	91	C	C	C
11	1610	A	77	89	A	A	A
12	272	B	58	56	B	B	B
13	2236	L	59	69	L	L	L
14	2265	E	64	78	E	E	E
15	2303		65	76			
16	2352		62	73			
17	2389		62	76			
18	2273		68	86			
19	1391		69	81			
20	755		66	75			
21	1506		64	74			
22	971		61	72			
23	451		64	69			
24	267		53	54			
25	551		47	49			
26	1636		54	69			
27	1008		64	70			
28	2091		66	78			
29	2251		69	84			
30	1598		70	83			
31	614		69	74			
SUM	47186	N.A.	-	-	-	-	-
AVG	1522	N.A.	64	73	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
AUXILIARY STORAGE PERFORMANCE

SITE: RADEMAKER CORP.-AIR SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	INCREASE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.006	0.000	0.006	68	-1.628
2	0.004	0.000	-0.001	70	26.756
3	0.002	0.000	-0.000	69	93.223
4	0.000	0.000	-0.005	69	527.527
5	0.003	0.001	0.000	68	3.593
6	0.004	0.000	0.004	68	-0.483
7	0.006	0.000	0.009	70	-9.366
8	0.000	0.000	-0.007	71	1.000
9	0.000	0.000	-0.001	70	1.000
10	0.000	0.000	-0.001	69	1.000
11	0.000	0.000	0.000	69	1.000
12	0.000	0.000	-0.000	69	1.000
13	0.002	0.000	0.002	69	-3.830
14	0.006	0.000	0.010	71	-12.902
15	0.005	0.001	0.005	74	0.496
16	0.000	0.000	-0.010	73	1.000
17	0.000	0.000	-0.004	70	1.000
18	0.000	0.000	-0.002	70	1.000
19	0.000	0.000	-0.001	69	1.000
20	0.000	0.000	-0.000	69	1.000
21	0.000	0.000	-0.000	69	1.000
22	0.000	0.000	-0.001	69	1.000
23	0.000	0.000	-0.000	69	1.000
24	0.000	0.000	-0.001	68	1.000
25	0.001	0.000	-0.004	68	1408.565
26	0.002	0.001	-0.001	67	3.265
27	0.002	0.000	0.003	67	-5.859
28	0.006	0.000	0.012	69	-31.175
29	0.000	0.000	-0.008	70	1.000
30	0.000	0.000	-0.001	69	1.000
31	0.000	0.000	0.001	69	1.000
SUM	0.047	0.005	0.003	-	-
AVG	0.002	0.000	0.000	69	9.622

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
MONTHLY REPORT
EXTRA LOAD SUBSYSTEM

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MONTH	LOAD MILLION BTU	SOLAR FRACTION OF LOAD PERCENT	SOLAR ENERGY USED MILLION BTU	CFER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU
1	0.167	100	0.167	0.100	0.000	N	0.031	-0.019	0.342
2	0.061	100	0.061	0.038	0.000	O	0.028	-0.012	0.138
3	0.017	100	0.017	0.028	0.000	T	0.028	-0.008	0.040
4	0.042	100	0.042	0.024	0.000		0.029	-0.001	0.071
5	0.272	93	0.249	0.118	0.022	A	0.029	-0.021	0.480
6	0.217	100	0.216	0.091	0.001	P	0.032	-0.021	0.425
7	0.137	100	0.137	0.084	0.000	P	0.026	-0.020	0.297
8	0.003	100	0.003	0.040	0.000	L	0.012	-0.007	0.077
9	0.004	100	0.004	0.010	0.000	I	0.008	-0.001	0.030
10	0.004	100	0.004	0.037	0.000	C	0.014	-0.006	0.071
11	0.005	100	0.005	0.027	0.000	A	0.027	-0.006	0.061
12	0.000	100	0.000	0.001	0.000	B	0.026	-0.001	0.001
13	0.019	100	0.019	0.015	0.000	L	0.024	-0.013	0.111
14	0.099	100	0.099	0.073	0.000	E	0.025	-0.018	0.251
15	0.051	100	0.051	0.031	0.000		0.027	-0.015	0.170
16	0.005	100	0.005	0.033	0.000		0.028	-0.006	0.090
17	0.052	100	0.052	0.027	0.000		0.028	-0.006	0.179
18	0.002	100	0.002	0.039	0.000		0.029	-0.006	0.085
19	0.004	100	0.004	0.003	0.000		0.026	-0.003	0.048
20	-0.001	100	-0.001	0.001	0.000		0.026	-0.001	0.002
21	0.006	100	0.006	0.018	0.000		0.027	-0.004	0.087
22	0.002	100	0.002	0.004	0.000		0.031	-0.001	0.033
23	0.000	0	0.000	0.000	0.000		0.028	0.000	0.000
24	0.001	100	0.001	0.002	0.000		0.027	-0.002	0.001
25	0.143	100	0.143	0.047	0.000		0.028	-0.010	0.243
26	0.229	77	0.171	0.082	0.058		0.082	-0.018	0.321
27	0.089	93	0.083	0.057	0.007		0.027	-0.021	0.168
28	0.087	90	0.076	0.053	0.011		0.029	-0.021	0.186
29	0.005	100	0.005	0.041	0.000		0.024	-0.007	0.075
30	0.004	100	0.004	0.013	0.000		0.026	-0.005	0.065
31	0.001	100	0.001	0.003	0.000		0.025	-0.000	0.004
SUM	1.728	-	1.628	1.143	0.100	N.A.	0.866	-0.282	4.149
AVG	0.056	95	0.053	0.037	0.003	N.A.	0.028	-0.009	0.134

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

SITE/SYSTEM DESCRIPTION:
THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ.FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING A 46% PROPYLENE GLYCOL SOLUTION THROUGH 6 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO THE DOMESTIC HOT WATER SUBSYSTEM AND TO A 560 GAL. INSULATED TANK. THE SPACE HEATING SUBSYSTEM IS AUGMENTED BY A 125,000 BTU/HR, NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	10.445	MILLION BTU
	43523	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	2.965	MILLION BTU
	12354	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	64	DEGREES F
AVERAGE BUILDING TEMPERATURE	73	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.16	
ECSS OPERATING ENERGY	0.136	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.982	MILLION BTU
TOTAL ENERGY CONSUMED	4.415	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	0.910	N.A.	0.910 MILLION BTU
SOLAR FRACTION	N.A.	91	N.A.	91 PERCENT
SOLAR ENERGY USED	0.862	0.822	N.A.	1.684 MILLION BTU
OPERATING ENERGY	N.A.	0.846	N.A.	0.982 MILLION BTU
AUX. THERMAL ENERGY	N.A.	0.088	N.A.	0.088 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	N.A.	0.469	N.A.	0.469 MILLION BTU
ELECTRICAL SAVINGS	N.A.	0.000	N.A.	-0.136 MILLION BTU
FOSSIL SAVINGS	N.A.	1.370	N.A.	1.370 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.243

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

4265

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: RADEMAKER CORP.-LIQUID SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

SITE/SYSTEM DESCRIPTION:
THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ.FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING A 46% PROPYLENE GLYCOL SOLUTION THROUGH 6 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO THE DOMESTIC HOT WATER SUBSYSTEM AND TO A 560 GAL. INSULATED TANK. THE SPACE HEATING SUBSYSTEM IS AUGMENTED BY A 125,000 BTU/HR. NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	11.020	GIGA JOULES
	494242	KJ/SQ.M.
COLLECTED SOLAR ENERGY	3.128	GIGA JOULES
	140291	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	18	DEGREES C
AVERAGE BUILDING TEMPERATURE	23	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.16	
ECSS OPERATING ENERGY	0.143	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	1.036	GIGA JOULES
TOTAL ENERGY CONSUMED	4.658	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	0.960	N.A.	0.960 GIGA JOULES
SOLAR FRACTION	N.A.	91	N.A.	91 PERCENT
SOLAR ENERGY USED	0.909	0.867	N.A.	1.776 GIGA JOULES
OPERATING ENERGY	N.A.	0.893	N.A.	1.036 GIGA JOULES
AUX. THERMAL ENG	N.A.	0.093	N.A.	0.093 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	N.A.	0.495	N.A.	0.495 GIGA JOULES
ELECTRICAL SAVINGS	N.A.	0.000	N.A.	-0.143 GIGA JOULES
FOSSIL SAVINGS	N.A.	1.446	N.A.	1.446 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.243

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.498	59	0.110	N	0.007	N	0.220
2	0.305	64	0.039	O	0.004	O	0.127
3	0.119	63	0.009	T	0.001	T	0.078
4	0.039	50	0.039		0.000		0.993
5	0.530	53	0.160	A	0.007	A	0.301
6	0.523	60	0.144	P	0.008	P	0.276
7	0.516	70	0.108	P	0.007	P	0.209
8	0.495	75	0.046	L	0.007	L	0.093
9	0.216	73	0.018	I	0.001	I	0.082
10	0.421	78	0.042	C	0.006	C	0.101
11	0.362	77	0.036	A	0.006	A	0.101
12	0.000	58	0.000	B	0.000	B	0.000
13	0.493	59	0.051	L	0.007	L	0.103
14	0.498	64	0.085	E	0.007	E	0.171
15	0.506	65	0.055		0.006		0.109
16	0.515	62	0.054		0.006		0.105
17	0.518	62	0.107		0.006		0.207
18	0.496	68	0.051		0.006		0.103
19	0.308	69	0.029		0.003		0.094
20	0.169	66	0.001		0.001		0.006
21	0.339	64	0.052		0.004		0.154
22	0.218	61	0.020		0.001		0.090
23	0.100	64	0.000		0.000		0.000
24	0.058	53	0.000		0.000		0.000
25	0.121	47	0.138		0.000		1.141
26	0.366	54	0.114		0.006		0.312
27	0.222	64	0.053		0.007		0.238
28	0.454	66	0.038		0.008		0.083
29	0.488	69	0.045		0.007		0.092
30	0.359	70	0.039		0.005		0.108
31	0.135	69	0.002		0.000		0.018
SUM	10.445	-	1.684	N.A.	0.136	N.A.	-
AVG	0.337	64	0.054	N.A.	0.004	N.A.	0.161
NBS ID	G001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: RADEMAKER CORP.-LIQUID SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.498	0.467	0.180	70	0.361
2	0.305	0.257	0.095	76	0.314
3	0.119	0.038	0.015	67	0.126
4	0.039	0.000	0.000	51	0.000
5	0.530	0.490	0.196	64	0.370
6	0.523	0.489	0.205	76	0.392
7	0.516	0.489	0.191	80	0.370
8	0.495	0.444	0.162	86	0.327
9	0.216	0.068	0.023	80	0.106
10	0.421	0.358	0.127	91	0.301
11	0.362	0.283	0.085	89	0.234
12	0.060	0.000	0.000	56	0.000
13	0.493	0.450	0.155	69	0.315
14	0.498	0.449	0.165	78	0.331
15	0.506	0.424	0.144	76	0.285
16	0.515	0.415	0.138	73	0.269
17	0.518	0.445	0.151	76	0.291
18	0.496	0.404	0.141	86	0.285
19	0.308	0.148	0.042	81	0.136
20	0.169	0.037	0.005	75	0.032
21	0.339	0.232	0.083	74	0.243
22	0.218	0.048	0.025	72	0.116
23	0.100	0.000	0.000	69	0.000
24	0.058	0.000	0.000	54	0.000
25	0.121	0.004	0.004	49	0.032
26	0.366	0.325	0.129	69	0.353
27	0.222	0.205	0.066	70	0.299
28	0.454	0.433	0.174	78	0.384
29	0.488	0.435	0.163	84	0.334
30	0.359	0.292	0.093	83	0.259
31	0.135	0.022	0.007	74	0.054
SUM	10.445	8.149	2.965	-	-
AVG	0.337	0.263	0.096	73	0.284
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: RADEMAKER CORP.-LIQUID SYSTEM SOLAR/2009-79/05
REPORT PERIOD: MAY.1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.125	0.068	0.044	103	0.895
2	0.064	0.014	-0.014	110	0.008
3	0.003	0.000	-0.021	106	-8.170
4	0.000	0.039	-0.068	99	1.000
5	0.131	0.104	0.020	92	0.942
6	0.129	0.078	0.039	95	0.906
7	0.134	0.063	0.063	106	0.936
8	0.102	0.000	0.064	124	0.629
9	-0.001	0.000	-0.038	125	28.481
10	0.069	0.000	0.048	129	0.690
11	0.038	0.000	0.001	134	0.037
12	0.000	0.000	-0.087	123	1.000
13	0.093	0.000	0.049	122	0.526
14	0.095	0.029	0.007	122	0.380
15	0.071	0.000	0.041	132	0.583
16	0.071	0.000	0.018	137	0.251
17	0.075	0.047	-0.005	137	0.558
18	0.074	0.000	0.017	139	0.223
19	-0.002	0.000	-0.030	139	19.033
20	0.002	0.000	-0.041	131	-17.364
21	0.021	0.000	0.016	129	0.749
22	-0.002	0.000	-0.038	126	17.473
23	0.000	0.000	-0.033	118	1.000
24	0.000	0.000	-0.026	112	1.000
25	-0.001	0.133	-0.112	95	-32.478
26	0.083	0.073	0.001	85	0.900
27	0.044	0.035	-0.002	85	0.762
28	0.128	0.000	0.118	95	0.924
29	0.107	0.000	0.079	119	0.738
30	0.040	0.000	0.013	129	0.319
31	-0.003	0.000	-0.044	124	15.300
SUM	1.691	0.683	0.079	-	-
AVG	0.055	0.022	0.003	117	0.451
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	N	N	0.038	N	N	N	N	N	N	N	N	N
2	O	O	0.022	O	O	O	O	O	O	O	O	O
3	T	T	0.007	T	T	T	T	T	T	T	T	T
4			0.000									
5	A	A	0.038	A	A	A	A	A	A	A	A	A
6	P	P	0.039	P	P	P	P	P	P	P	P	P
7	P	P	0.041	P	P	P	P	P	P	P	P	P
8	L	L	0.043	L	L	L	L	L	L	L	L	L
9	I	I	0.014	I	I	I	I	I	I	I	I	I
10	C	C	0.039	C	C	C	C	C	C	C	C	C
11	A	A	0.031	A	A	A	A	A	A	A	A	A
12	B	B	0.000	B	B	B	B	B	B	B	B	B
13	L	L	0.048	L	L	L	L	L	L	L	L	L
14	E	E	0.051	E	E	E	E	E	E	E	E	E
15			0.050									
16			0.049									
17			0.055									
18			0.049									
19			0.024									
20			0.002									
21			0.046									
22			0.018									
23			0.000									
24			0.000									
25			0.003									
26			0.022									
27			0.018									
28			0.036									
29			0.040									
30			0.035									
31			0.002									
SUM	N.A.	-	0.862	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	-	-	N.A.
AVG	N.A.	N.A.	0.028	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.CT LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION ETU	AUX THERMAL USED MILLION ETU	AUX ELECT FUEL MILLION ETU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.071	100	0.071	0.078	0.000		0.018	0.000	0.119	73	59
2	0.017	102	0.017	0.025	0.000		0.016	0.000	0.028	73	64
3	0.002	102	0.002	0.020	0.000		0.015	0.000	0.003	74	63
4	0.039	100	0.039	0.023	0.000		0.013	0.000	0.065	72	50
5	0.140	87	0.121	0.095	0.018		0.015	0.000	0.202	70	53
6	0.106	100	0.105	0.069	0.001		0.015	0.000	0.175	71	60
7	0.067	100	0.067	0.063	0.000		0.015	0.000	0.111	76	70
8	0.003	101	0.003	0.033	0.000		0.006	0.000	0.005	77	75
9	0.004	100	0.004	0.009	0.000		0.004	0.000	0.006	74	73
10	0.004	100	0.004	0.031	0.000		0.007	0.000	0.006	75	78
11	0.005	100	0.005	0.021	0.000		0.014	0.000	0.008	75	77
12	0.000	0	0.000	0.000	0.000		0.013	0.000	0.000	74	58
13	0.003	101	0.003	0.002	0.000		0.013	0.000	0.005	69	59
14	0.034	100	0.034	0.053	0.000		0.017	0.000	0.056	74	64
15	0.005	100	0.005	0.016	0.000		0.017	0.000	0.008	75	65
16	0.005	100	0.005	0.028	0.000		0.014	0.000	0.008	74	62
17	0.052	100	0.052	0.021	0.000		0.014	0.000	0.086	73	62
18	0.002	175	0.002	0.034	0.000		0.015	0.000	0.004	74	68
19	0.004	100	0.004	0.000	0.000		0.013	0.000	0.007	74	69
20	-0.001	-59	-0.001	0.000	0.000		0.013	0.000	-0.002	73	66
21	0.006	100	0.006	0.014	0.000		0.014	0.000	0.011	73	64
22	0.002	100	0.002	0.003	0.000		0.016	0.000	0.003	72	61
23	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	73	64
24	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	72	53
25	0.134	100	0.134	0.036	0.000		0.010	0.000	0.224	69	47
26	0.143	64	0.092	0.062	0.051		0.065	0.000	0.154	69	54
27	0.042	88	0.035	0.035	0.007		0.013	0.000	0.058	71	64
28	0.012	17	0.002	0.032	0.011		0.018	0.000	0.003	71	66
29	0.005	100	0.005	0.034	0.000		0.012	0.000	0.008	73	69
30	0.004	100	0.004	0.008	0.000		0.013	0.000	0.007	74	70
31	0.001	100	0.001	0.003	0.000		0.013	0.000	0.001	75	69
SUM	0.910	-	0.822	0.846	0.088	N.A.	0.469	0.000	1.370	-	-
AVG	0.029	91	0.027	0.027	0.003	N.A.	0.015	0.000	0.044	73	64
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MAY,1979

SOLAR/2009-79/05

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	2076	N	59	70	N	N	N
2	1269	O	64	76	O	O	O
3	494	T	63	67	T	T	T
4	163		50	51			
5	2207	A	53	64	A	A	A
6	2178	P	60	76	P	P	P
7	2151	P	70	80	P	P	P
8	2061	L	75	86	L	L	L
9	899	I	73	80	I	I	I
10	1754	C	78	91	C	C	C
11	1507	A	77	89	A	A	A
12	249	B	58	56	B	B	B
13	2056	L	59	69	L	L	L
14	2073	E	64	78	E	E	E
15	2110		65	76			
16	2145		62	73			
17	2160		62	76			
18	2068		68	86			
19	1281		69	81			
20	704		66	75			
21	1414		64	74			
22	908		61	72			
23	415		64	69			
24	243		53	54			
25	503		47	49			
26	1524		54	69			
27	924		64	70			
28	1891		66	78			
29	2034		69	84			
30	1496		70	83			
31	562		69	74			
SUM	43523	N.A.	-	-	-	-	-
AVG	1404	N.A.	64	73	N.A.	N.A.	N.A.
NBS ID	G001		N113			N115	N114

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